

Development of Real-Time Gas Quality Sensor Technology

Introduction

Landfill gas (LFG), composed largely of methane and carbon dioxide, is used in over 645 operational projects in 48 states. These projects convert a large source of greenhouse gases into a fuel that currently provides approximately 51 trillion Btu of electricity and supplies 108 billion cubic feet of LFG annually to direct use applications and natural gas pipelines. However, there is still a significant resource base for new projects, with over 440 untapped candidate landfills across the country. Landfill gas and other opportunity fuels, such as digester gas from wastewater plants and coal-mine methane, need improved gas-utilization technology in order to lower costs, increase system efficiencies, and provide more effective and environmentally friendly gas cleanup.

This project brought together novel gas quality sensor (GQS) technology with engine management for opportunity fuels such as landfill gas, digester gas and coal bed methane. By providing the capability for near real-time monitoring of the composition of these opportunity fuels, the GQS output can be used to improve the performance, increase efficiency, raise system reliability, and provide improved project economics and reduced emissions for engines used in distributed generation and combined heat and power.

Benefits for Our Industry and Our Nation

The project allows for wider use of LFG, turning a significant source of greenhouse gas into a fuel that displaces electric power generation. The technology was designed for increased productivity and easier system implementation as an integrated prefabricated modular product, reducing time and money spent on custom engineering for future applications.

Applications in Our Nation's Industry

This technology has extensive applications in LFG industries. Applications will also be found in other industries that include wastewater treatment (digester gas) and coal-mine methane, as well as in a growing market for digesters that use agricultural waste.

Project Description

The goal of this project was to bring together real-time gas quality sensor technology with engine management for opportunity fuels. The project was a unique industry effort that will improve the performance, increase efficiency, raise system reliability, and provide improved project economics and reduced emissions.



A gas quality sensor (GQS) setup at Bath Landfill, Steuben County, NY. Real-time GQS technology and engine control system improvements are addressing fuel quality issues with opportunity fuels such as landfill gas and digester gas.

Photo courtesy of GTI

Barriers

- Development of an absorption chiller-based gas dryer, driven by waste thermal energy from the engine
- Development of a new engine monitoring and control system capable of detecting fuel heating value and composition variability, while also maintaining reliable engine operation at optimum conditions
- Development of an exhaust-gas recirculation system that reduces engine exhaust (NO_x) levels and permits engine operation closer to the maximum efficiency point

Pathways

The project modified an existing design for LFG, digester gas, and other opportunity gaseous fuels to utilize waste heat instead of electricity to drive the cooling process within the system. This increases output of electric power from the system, increases system reliability, reduces net emissions, improves engine efficiency, and reduces maintenance costs by improving gas quality.

Milestones

- Development of a gas-quality sensor for real-time detection of opportunity fuel composition and heating value to provide the air/fuel ratio controller with a necessary feed-forward input
- Development of software and a control system for the air-fuel ratio controller for opportunity fuels

- Development and testing of the cooled exhaust-gas recirculation system required for maintaining stoichiometric operation of the opportunity fuel-powered field-test engine with three-way catalyst to control emissions
- Combination of the gas quality sensor, advanced engine controller, and exhaust-gas recirculation into an integrated prototype system on a multicylinder test engine for operation on simulated opportunity-fuel composition

Accomplishments

- Advanced development of a low-cost, near infrared sensor for real-time monitoring of the concentrations of methane and carbon dioxide in opportunity fuels such as landfill gas and digester gas from wastewater treatment plants.
- Installed the developed sensor at two landfills and one wastewater treatment plant where long-term testing was conducted to compare accuracy of the gas quality sensor (GQS) versus a gas chromatograph (the industry standard for gas analysis).
- Expanded the capabilities of the GQS to include measurement of hydrogen and carbon monoxide in opportunity fuels such as producer gas from gasification and pyrolysis of biomass.

Commercialization

The project partners offer a unique coordination of technologies that is necessary to improve upon available technologies and successfully commercialize project products. An advanced engine-combustion control system, including key sensor and control system elements, will be commercialized for use with other opportunity fuels. CMR Group was identified as a commercial partner to negotiate agreements for the commercialization of the gas quality sensor (GQS). CMR provides design, manufacturing, and service of instrumentation and controls for offshore platforms and vessels, marine, engines, and industrial applications worldwide.

Project Partners

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Project final report available at
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